A Preliminary Gravity Survey of the Island of Lanai, Hawaii[1]

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THE GRAVITY VALUE of the base station at Kahului Airport, Maui, was measured at 978.88927 gal by R. R. MacDonald and W. T. Kinoshita in 1961 and 1962 (written communication). Gravity differences measured between Maui and Lanai during this survey confirm the base value of 978.84757 gal established by R. R. MacDonald at Lanai Airport in 1961. LaCoste and Romberg gravity meter G-8 was used to establish both of these base stations. Figure 1 shows the location of both gravity bases used on Lanai; the Lanai Inn base was used for control before and after each day's survey. Table 1 lists the date, time, and reading in milligals at the base station (Lanai Inn) from which all of the loops on Lanai were originated. These data are introduced to demonstrate the drift-free behavior of the meter. Gravity meter readings were not corrected for instrumental drift because the drift would involve errors of the order of tenths of a mgal, whereas uncertainties in elevation and in station location could introduce errors of the order of 1 mgal. The reconnaissance nature of the survey, as well as the size of the gravity anomalies anticipated, obviated the necessity for the drift and tidal corrections which would have been needed for a more detailed gravity study where elevation, location, and bulk density were better known.

The table of principal facts for the gravity survey on Lanai is reported elsewhere (Hawaii Inst. Geoph., 1965, Table 4). A few U. S. Geological Survey and U. S. Coast and Geodetic Survey benchmarks and triangulation stations were located and occupied. Other stations were at rain gauge sites maintained and surveyed by the Lanai Plantation, Dole Corporation. The Plantation field maps were the most recent charts available for this gravity survey, and the rain gauge sites shown on them were convenient in number and distribution for use as gravity stations. The present engineering staff of Dole Corporation is not certain how the rain gauges were located or how their elevations were determined. It seems probable that the majority of the rain gauges were located by horizontal triangulation and that their elevations were then read from existing (1921, 1940) U. S. Geological Survey topographic maps of the island. Uncertainties lead to the possibility that any station may be in error by as much as 10 ft of elevation. Adjacent stations could have a relative elevation error as large as 20 ft. An error of 20 ft in elevation would be the equivalent of about 1.3 mgal.

At the latitude of Lanai a change of 1′ in latitude is roughly equal to 1 mgal in theoretical gravity. Gravity errors due to mislocation, therefore, would probably be less than a few tenths of a mgal. Gravity errors resulting from errors in both elevation and location could be as large as 2 mgal.

Woollard (1951) used a density of 2.3 g/cc to reduce gravity data for Oahu to a sea level datum. He based that choice on gravity profiling computations using Vening Meinesz' submarine data. Gravity data on the island of Hawaii were reduced on the same basis of 2.3 g/cc (Krivoy and Eaton, 1961). Recent density determinations appear to confirm that choice. On Lanai the choice of bulk density to sea level is complicated by a rather thick weathering zone which seems to cover the island with varying depths of low density soil, talus, and detrital fill.

THE EFFECT OF VARIOUS DENSITIES ON THE BOUGUER GRAVITY MAP

Thus far, other Hawaiian volcanic units studied with gravity methods have been mapped on

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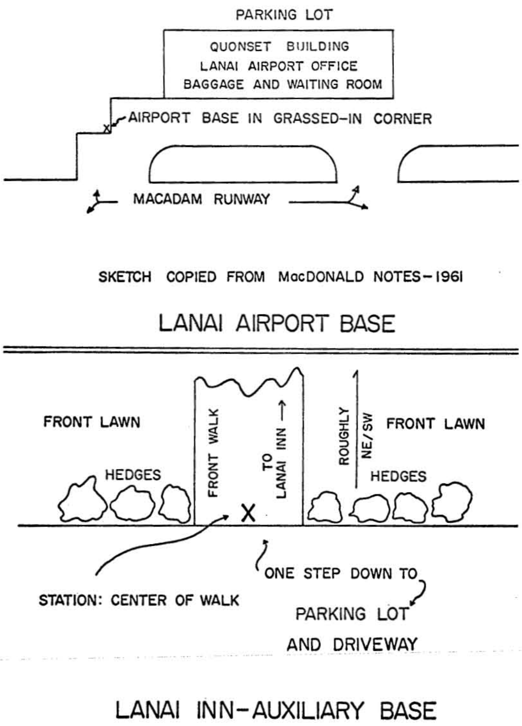

FIG. 1. Sketch showing locations of two gravity base stations on Lanai, Hawaii, used in this preliminary survey.

the assumption that bulk density above sea level was 2.3 g/cc. Because of the accumulation of low density material at the surface, an elevation correction factor of 0.0695 mgal/ft was used in reducing Lanai data for the map of Figure 2. This factor corresponds to a density of 2.0 g/cc.

Use of 2.0 instead of 2.3 for specific gravity has the result of enhancing the gravity anomaly centered on the Palawai Basin. The 40–60-mgal Bouguer anomaly over the assumed center of volcanism is a prominent feature of the gravity fields of other Hawaiian volcanoes (Kinoshita et al., 1963). The 40-mgal anomaly centered on the Palawai Basin is the major gravity feature on Lanai. The geological interpretation of Stearns (1940) suggests that the Lanai plateau and its contemporary depressions are the remains of the ancient center of volcanism for Lanai Volcano. The gravity interpretation tends, therefore, to confirm the geologic one.

IMPLICATIONS OF THE LANAI BOUGUER ANOMALY

Figure 2 shows the well-defined Palawai anomaly. The gravity ridge to the northwest indicates the possibility of an ancient rift in that direction. There is less control to the southeast where another rift zone could possibly exist. From R-10 and R-4 one gets a wonderful view of the scenery; but these stations are poor from the point of view of near-station elevation change. Whereas other stations along the beach or on the plateau get terrain corrections of less than 1 mgal, computed terrain corrections for stations on the mountain go from 5 to 15. And in some cases they would be even higher were the terrain variations fully known and accounted for. Thus R-4 and R-10, as plotted, represent idealized Bouguer anomalies which contain very liberal terrain corrections. Stations along the eastern shore of Lanai would be especially useful in delineating any east-west gravity trend not clarified by the present coverage. Such additional coverage is suggested, as well as possible additions on and around the northwest lobe of Lanai.

ACKNOWLEDGMENTS

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TABLE 1

READINGS AT LANAI INN, CORRECTED ONLY FOR TIDAL EFFECT

DATE	TIME	READING (mgal)
12-27-62	13:16	2472.43
12-27	16:11	2742.49
12-27	18:18	2472.53
12-28	07:40	2472.55
12-28	18:10	2472.58
12-29	08:30	2472.64
12-29	11:58	2472.48
12-29-62	13:25	2472.54

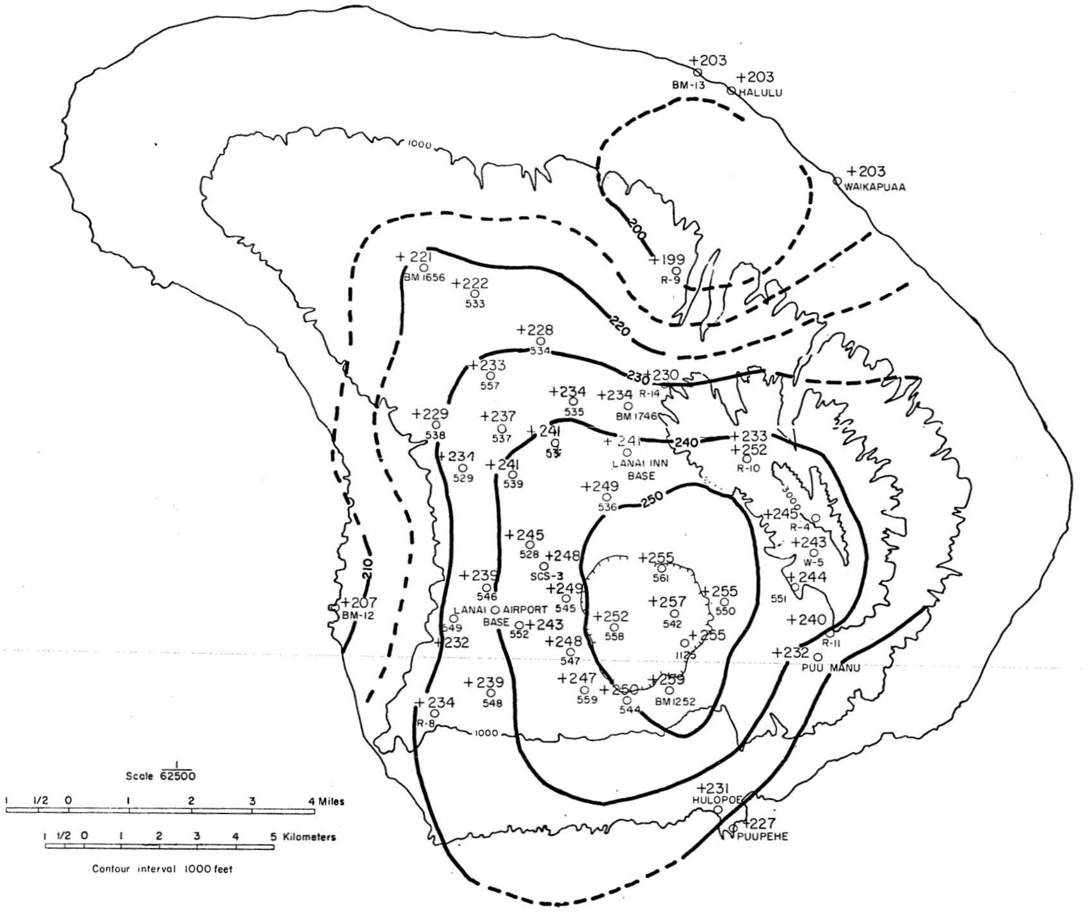

FIG. 2. Bouguer gravity anomaly map of **Lanai, Hawaii.**

review the work and to supply additional data. We appreciate the interest and cooperation of Captain Wilbur Porter, U. S. Coast and Geodetic Survey District Officer in Honolulu, who permitted use of a Coast Survey triangulation jeep being stored on Lanai.

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